Assessing efficiency in general practice: an application of data envelopment analysis

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As with any health care process, the efficiency with which outputs are produced in general practice is of considerable importance. Using data from Lincolnshire, this study utilizes data envelopment analysis to examine the relationships between practice costs and outputs, measured not only as the number of patients treated, but also on the basis of performance indicators. The technique permits the construction of an efficiency ranking, facilitating the accurate targeting of monitoring resources.

Introduction

The general practitioner (GP) plays an extremely influential role in the UK's National Health Service (NHS). Under the terms of service, the GP assumes responsibility for the health care needs of a list of patients, and every member of the UK population is entitled to inclusion on a GP list. The costs of the primary care services provided by GPs directly account for around 20% of annual NHS spending and over half this amount comprises the costs of prescribed drugs and medicines (Orton and Fry, 1995). In addition, and for the vast majority of patients, GPs represent the direct line of access to other levels of the NHS, and GPs' patient management decisions are thus significant in determining the overall utilization of hospital care.

Since the publication of the 1989 White Paper, Working for Patients, and the passage of the 1990 NHS Act, the pursuit of efficiency has been a primary goal of NHS management. The definition of efficiency in general practice, however, has proved particularly problematic, not least because of the uncertainties associated with GPS' formal responsibilities and performance criteria. Indeed, the terms of service prior to 1990 were somewhat unhelpful in this respect, the GP being required to 'render to his patients all necessary and appropriate personal medical services of the type usually provided by general medical practitioners' (Department of Health, 1989). More recent events, however, have conspired to effect more operational definitions, even if the intentions were not explicit as such. For example, the British Medical Association has been active in promoting debate about the definition of 'core and 'non-core' services in general practice (General Medical Services Committee, 1996). Although the search for such definitions may have been motivated by GPs' desires to protect themselves from an ever increasing workload, clearer criteria against which performance quality could

be judged are likely to result. Beyond this debate, there is evidence of increasing use of economic criteria of performance, in two respects. First, the introduction of the voluntary devolved budgets or 'fundholding' scheme into general practice in 1991 was designed both to instil a sense of management discipline into practice finance and to stimulate competition amongst secondary care suppliers from whom fundholders would be purchasing care services (Whynes, 1993). These funds were intended to cover the costs of prescribed drugs and those of a range of inpatient and outpatient referrals. Non-fundholders were allocated target pre- scribing budgets, with the result that financial management (more specifically, keeping within budgets) in both types of practice has emerged as an implicit performance criterion. Second, the new GP contract, introduced in 1990, altered the manner in which GPs earned their incomes. Henceforth, more weight was to be placed on capitation fees based on list-size in relation to basic fixed allowances. A selection of activities, such as health promotion and child health surveillance, were removed from the GP's 'core' responsibilities and became the subject of fees-for-service. Three activities which had previously attracted fees-for-service-screening for cervical cancer and two immunization programmes for children-were now to attract target payments. As the name implies, the income received in such cases would be determined by the extent to which GPs were successful in reaching certain established targets. In comparison with the pre-1990 structure, economic incentives are now far more clearly defined. Responsibility for more patients will now bring proportionately more income, as will the provision of more fee-for-service items and the achievement of higher target levels. In that increased responsibility and activity rates offer the scope for higher incomes, the presumption must be that more of the former represents superior performance. Without sucha presumption, of course, the incentives would be perverse.

Efficiency Analysis

Accepting the importance of economic considerations in assessing performance and efficiency, this paper reports the results of an efficiency analysis of the 107 general practices in Lincolnshire for the financial year 1993-–1994. Efficiency relates to the transformation of inputs into outputs. In our analysis, inputs were represented by four types of annual financial costs for each practice, namely:

(i) Staff costs, i.e. discretionary staff payment made by each practice, but not including the nationally-determined statutory payments made to GPs
(ii) Costs of medicines prescribed by the G in the practice
(iii) Capital and variable costs of computers
(iv) Rent and rates pertaining to practice premises.

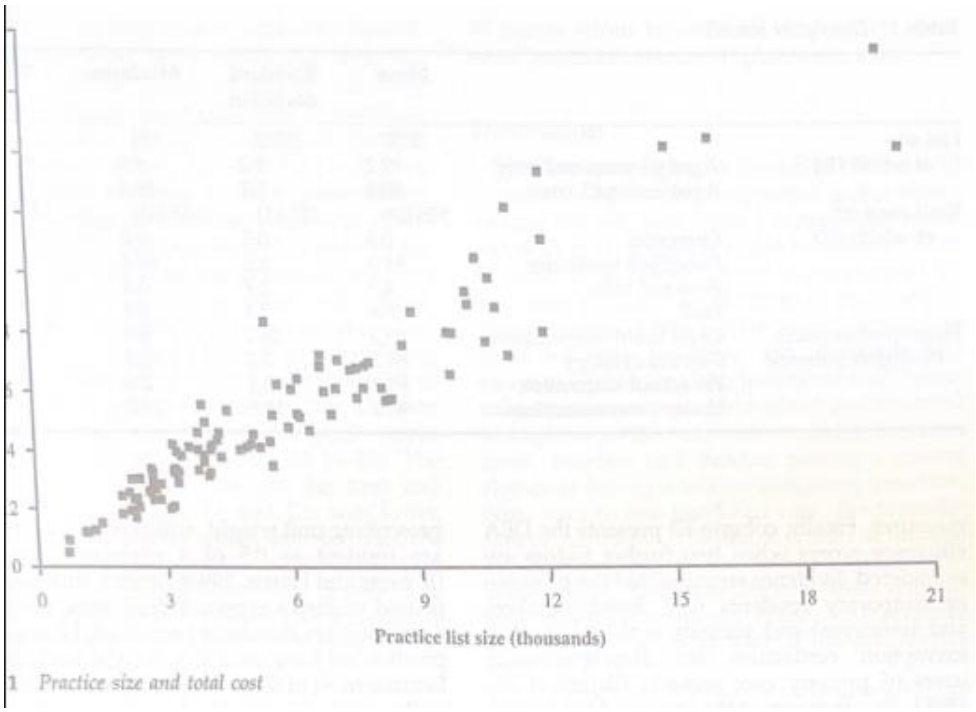
We defined three increasingly complex measures of practice output. The first a simplest was the size of the practice list, implying a notion of efficiency as numbers of patient treated per annum per unit of cost. As t consumption of medical resources is known

increase with age (Harris et al., 1990), followed convention by considering t members of the list aged 65 years and over. independently from those aged under years. Thus, in this simplest formulation, practice would be deemed more efficient than another if it were to be responsible for more both types of patients per unit of input expended. Second, we considered a joint output, namely list size as before and recorded practice performance with respect to the proportion of the practice's eligible:

(i) Patients given a cervical cytology test
(ii) Children under 2 years of age given vaccinations
(iii) Children given immunizations prior to starting school
(iv) Children given a general health surveillance.

The first three of these activities attract targe payments, whilst the fourth is a fee-for-service item. Finally, we considered the above joint output in relation to the presence of certain patient characteristics known to exert an influence on practice behaviour.

Our efficiency assessments were based on data envelopment analysis (DEA). The DEA technique calculates the ratio of weighted outputs to weighted inputs, and enables any number of outputs to be considered (Charnes et, al., 1978). The technique is well established in health economics, although the majority of previous applications have been in the field of secondary care (Various authors, 1994). Within the DEA approach there are different ways of examining returns to scale. It is often postulated that, as there are fixed costs in running a several practice, economies of scale exist. However, our data, as presented in Fig. 1, revealed little evidence of such economies and therefore proceeded on the assumption of constant returns to scale, i.e. costs per patient unaffected by list size.



1 *Practice size and total cost*

Results

Table 1 presents descriptive statistics pertaining our input and output measures. As may be seen, prescribing costs are the dominant component of total costs in all cases. Using total costs the measure of input, and patients in the two age groups as outputs, the DEA classified four practices as 100% efficient. Figure 2 depicts the formation graphically, as points in possibilities space. The data envelopment technique lows a practice to be regarded as 100% efficient if there is no combination of other practices which yields a higher output of all kinds er unit cost. Whilst the more traditional statistical method would attempt to derive a relationship estimating the cost per elderly patient as a multiple of each younger patient treated, the DEA technique does not impose such strong assumptions. Practice R, for example, is regarded as 100% efficient, treating an extra 0.118 elderly patients and 1.025 less young patients per £1000 in comparison with practice F. The implied additional cost ratio is thus 8.7 for elderly patients relative to the young. In comparison with practice W, practice L treats an extra 0.825 young patients but 1.311 less elderly patients per £1000.

In the second stage of the analysis we introduced the four performance measures. To begin with, we added additional factors one at a time, although it was observed that subsequently adding the remaining three to any one of the performance measures initially entered made insubstantial changes to the measures of efficiency. Consequently, we developed a composite measure of performance, based on principal components analysis. The weights emerging from the principal components analysis were 0.2160, 0.3056, 0.2989, 0.1795 for cytology, under two vaccinations, pre-school immunizations, and child health surveillance, respectively.

Column E1 in Table 2 presents the efficiency results of the initial DEA which were portrayed graphically in Fig. 2. For brevity, data for only the top 14 and bottom 11 practices are included. Column E2 in Table 2 presents the second stage results, i.e. efficiency scores based on the combined outputs of list size and performance measures. Finally, column E3 presents the DEA efficiency scores when two further factors are considered. Evidence suggests that the presence of temporary residents (e.g., holiday-makers and transients) and patients with prescription exemption certificates are disproportionate users of primary care services (Baines et al., 1996). As a measure of the impact of temporary residents, we employed the conventional prescribing unit weight, which counts a temporary resident as 0.5 of a permanent resident (Roberts and Harris, 1993). Strictly, this measure is used to derive expected drug costs, but since drug costs are the major part of total costs for a practice we have used this weight unchanged. Because most of these temporary visitors will be in the under-65 age group we have added the figures to that age group. The number of exemptions was treated as a separate variable, but these numbers were subtracted

from the under-65 patients (patients above this age would not require formal payment exemption).

Table 1. Descriptive statistics

	Mean	Standard deviation	Minimum	Maximum
List size	5727	3732	691	20,115
of which (%) Aged 65 years and over	19.2	5.2	9.8	40.6
of which (%) Aged under 65 years	80.8	5.2	59.4	90.2
Total costs (£)	535,839	327,141	52,510	1,792,956
of which (%) Computer	0.8	0.7	0.0	3.6
of which (%) Prescribed medicines	84.0	4.2	69.4	94.4
of which (%) Rent and rates	4.3	2.7	0.2	19.2
of which (%) Staff	10.8	2.5	1.4	19.7
Target performances (% eligible patients)				
Child health surveillance	85.3	24.1	0.0	100.0
Cervical cytology	84.3	7.3	51.3	94.4
Pre-school vaccination	89.3	13.1	2.4	100.0
Under-2 immunizations	90.4	14.6	15.2	100.0

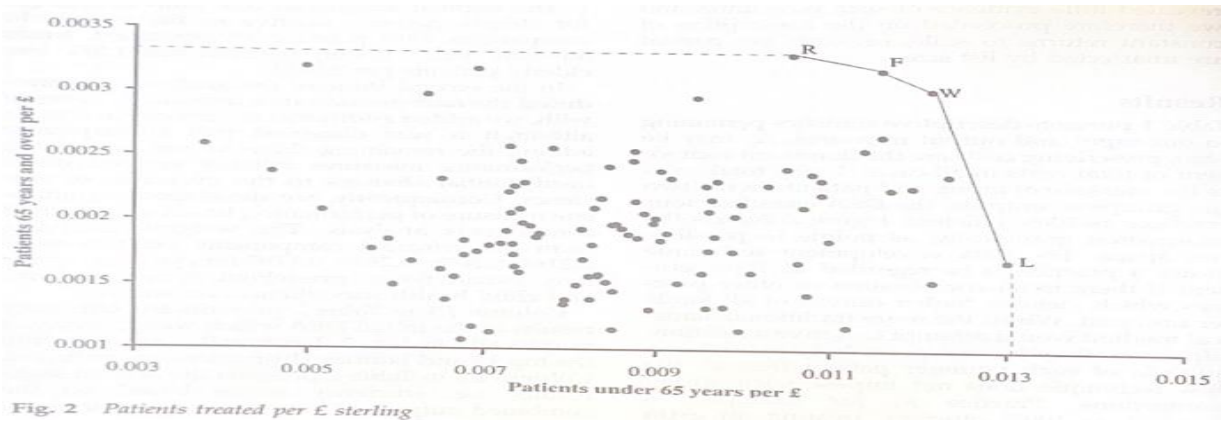


Fig. 2 *Patients treated per £ sterling*

The correlation coefficient between the first two efficiency scores, E1 and E2, was 0.96, implying that assessed practice performance varied little when an additional efficiency criterion was added. Practices efficient in terms of the single output also emerged as broadly efficient when assessed against a combined output. Translating the scores into rankings, the move from E1 to E2 entailed 84.1% of practices being ranked equal or lower, with a maximum fall in position of six placed for any practice. The two highest rises in position were 32 places (from rank 100 to 68) and 20 (from 89 to 69). The correlation coefficient between the first and final efficiency scores, E1 and E3, was lower, at 0.85. Translating the scores into rankings, the move from E1 to E3 entailed 64.5% of practices being ranked equal or lower, with a maximum fall in position of 20 places for any practice. In this case, the single highest rise in position was 96 places (from rank 97 to 1) although three other practices rose by 60 places or more.

Table 2. Efficiency scores for Lincolnshire practices

E1	E2	E3	E3 rank
100	100	100	1 =
100	100	100	1 =
100	100	100	1 =
100	100	100	1 =
87	100	100	1 =
56	57	100	1 =
98	98	98	8 =
97	98	98	8 =
96	97	97	10
94	94	96	11
95	95	95	12 =
93	93	95	12 =
85	88	95	14

Discussion

DEA chooses weights to maximize the ratio of outputs to inputs for the practice under observation. The results of Table 2 indicate that seven practices in Lincolnshire might be

deemed 100% efficient, in that they are not out-performed by any other practices on the basis of that weighting structure. Table 2 also indicates that the most efficient practices are approximately twice as efficient as the lowest-ranked. Naturally, efficiency scores for a given practice tend to improve as the output formulation becomes more complex, each practice gaining a greater chance of having a unique weighting structure. Note that, in one particular case, the formulation of the output function is crucial in moving the practice from a low, to a very high, efficiency score. The implication is that, without such information being taken into account, that practice would be graded (mistakenly) as inefficient.

Evidence from Lincolnshire with respect to prescribing costs has already suggested that practices permitted to dispense their own prescriptions to their patients exhibit higher costs (Baines et al. [in press]) and that GP fundholders are lower cost prescribers than their non-fundholding counterparts (Whynes et al., 1995). These previous results are in large part consistent with the DEA results. Of the 20 practices ranked lowest by E3 score, 19 were dispensing practices and the mean score for dispensers of 73.6 was significantly lower than that for non-dispensers (t-test, $P > 0.01$). The mean E3 score for the 19 fundholders joining between 1991 and 1993 was 82.2%, significantly higher than the mean score of 76.4% for no fundholders (t-test, $P > 0.05$)The efficiency scores of fundholders joining in subsequent waves did not differ significantly from those of non-fundholders, lending support to the hypothesis that early-wave fundholders may well have pre-selected themselves on efficiency grounds (Baines and Whynes, 1996). This having been said, it is interesting to note that only one of the seven practices rated as 100% efficient was a fundholder in one of the first three waves.

In a world of limited managerial resources, the monitoring of general practice will pose considerable problems unless some form of pre-selection is undertaken. The construction of an efficiency index as described can be extremely useful in targeting monitoring resources, by identifying those practices widely at variance with perceived good performance. The output criteria employed in this analysis are suggestive rather than definitive, and designed to illustrate the use of the technique as a management tool. DEA is technically capable of accommodating higher numbers of outputs, and the potential for a more complete definition of efficiency is thus governed by data availability. For example, amongst the further candidates for inclusion in a performance index would be hospital referrals by specialty, episodes of minor surgery and other fee-for service items.

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